ON THE ABSORPTION OF HYDROGEN CHLORIDE INTO VARIOUS ORGANIC LIQUIDS AND CALCULATION OF THE HEAT OF ABSORPTION. I.

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On account of the great interest in solubility in general, and especially in the possible relations between various physical and chemical properties of solutes as well as of solvents and solubilities, numerous investigations have been carried out. However, there is not yet a theory which enables us to account for all types of solubility dada, although there is a definite trend as to what direction we should look for. Hildebrand gives an excellent discussion in his book "Solubility" and he states in his introductory remark, "The solubility of one substance in another depends fundamentally upon the ease with which the two molecular species are able to mix, and if the two species display a certain hostility towards mixing, not only will saturation be attained at smaller concentration, but in the unsaturated solution the tendency to mutual segregation will give rise to a partial separation or adsorption of one species at the surface, with a consequent lowering of surface tension. It is likely also to give rise to an expansion and absorption of heat upon mixing, phenomena not ordinarily connected with solubility". Thus the investigation of solubility is not only highly practical, but also very fascinating and interesting from a theoretical standpoint. With this view, the present author has undertaken the investigation on some aspects of solubility of gases in various organic solvents.

In order to systematize various solubility data several attempts have hitherto been done to find general laws which govern the solubility. We have a great deal of evidences that polarity of substances involved has much to do with the solubility. Still another criterion which has been taken into account is the relations between the solubilities and the internal pressures of substances, as measured by $-T\frac{\alpha}{\beta}$ which was proposed by Dupré:(1)(2)

$$T\left(\frac{\partial P}{\partial T}\right)_V = -T\frac{\alpha}{\beta}\,, \tag{1}$$

where α is the coefficient of expansion, β the coefficient of compressibility, and the term $T\left(\frac{\partial P}{\partial T}\right)_V$ appears in the thermodynamic equation of state, namely

$$P+\left(\frac{\partial E}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V\,. \tag{2}$$

The purpose of the present investigation is to see whether the solubility of a relatively polar gas in various non-polar liquids can be correlated with the various chemical and physical properties of these non-polar liquids.

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(1) Dupré, *Ann. chim. phys.*, **2** (1864), 201.

(2) For fuller discussion of internal pressure, see "Solubility" by Hildebrand, Chem. Catalogue Co.

As a polar gas hydrogen chloride(2a)(3) is chosen, and as non-polar liquids carbon tetrachloride, ethylene chloride, ethylene bromide, and 1,1,2,2-tetrachlorethane are selected.

Experimental Procedure. The method for measuring the absorption of hydrogen chloride into these liquids consists in finding the volume of hydrogen chloride absorbed by a given amount of these liquids. The measuring apparatus of hydrogen chloride is a U-shaped gas burette which is filled with mercury, and calibrated to 0.5 c.c., and can be read to 0.1 c.c., and at the same time the pressure of hydrogen chloride plus the vapour pressure of the liquid used, which has absorbed hydrogen chloride also can be read so that the amount of hydrogen chloride absorbed at various pressures can be obtained. The U-shaped gas burette is provided with water jacket. During a run there is practically no variation of temperature, so that the water in the jacket is stopped from flowing. The absorption vessel is about 80 c.c. in capacity and connected to the gas generating system through a capillary tube and also to an ordinary mercury manometer with a stopcock to cut it off from the absorption chamber during the absorption experiment. The vessel is also connected to the graduated liquid reservoir at the top from which a given amount of liquid is introduced into the absorption vessel after the vessel has been evacuated. The whole absorption vessel is immersed in the thermostat with constancy of $\pm 0.1^\circ$. Between the gas burette and the absorption chamber a vessel of 335 c.c. capacity is inserted as a gas reservoir which is also immersed into the thermostat in order to make the gas to acquire the same temperature as the liquid before entering the absorption vessel. Furthermore, in order to saturate the liquid with hydrogen chloride thoroughly, the whole absorption apparatus is shaken by tapping from time to time until there occurs no more absorption. One to one and a half hours are usually sufficient to establish the equilibrium. Thus from the volume change in

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(2a) Debye, "Polar Molecules," Chem. Catalogue Co.; F. I. G. Raulins, *Z. Physik*, **50** (1928), 440; J. H. Van Vleck, "The Theory of Electric and Magnetic Susceptibilities," Oxford Press; L. Pauling, *J. Am. Chem. Soc.*, **54** (1932), 988.

(2b) L. Pauling, "The Nature of The Chemical Bond. IV," *J. Am. Chem. Soc.*, **54** (1932), 3570.

(2c) L. Pauling and J. Sherman, *J. Chem. Phys.*, **1** (1933), 606.

(3) Recent development in the quantum mechanics seems to show that as far as the valence in HCl is concerned it may be regarded perhaps more non-polar in nature, although it is more or less accepted as a polar gas from the dielectric measurement and the direct measurement of the electric moment by the molecular ray method. Zahn, *Phys. Rev.*, **24** (1924), 400; Estermann and Fraser, *J. Chem. Phys.*, **1** (1933), 390.

the gas burette, the initial and final pressures, and the volume of the system, the volume (ΔV) of hydrogen chloride actually absorbed into the liquid is calculated.

The Materials Used. Hydrogen chloride was prepared by dropping concentrated hydrochloric acid into pure concentrated sulphuric acid, passing the gas through two sulphuric acid bubblers, and condensing twice with liquid nitrogen. Only the middle portion of it was used after passing it finally through a calcium chloride tube before it was allowed to enter into the burette and reservoir.

1,1,2,2-Tetrachlorethane (Kahlbaum's product, b.p. 143.5—144°) was distilled twice. The another sample of 1,1,2,2-tetrachlorethane was kindly supplied by Dr. Fukagawa of the Institute of Physical and Chemical Research, Tokyo, to whom the author wishes to express his best thanks.

Carbon tetrachloride (Kahlbaum's product, b.p. 76.0°), ethylene chloride (Takeda's product, b.p. 83.0°), and ethylene bromide (Takeda's product, b.p. 129.0°) were all distilled twice.

Results. For all of these organic liquids, the volume of hydrogen chloride absorbed was plotted against respective pressures at which the system finally reached an equilibrium, one of examples, of 1,1,2,2-tetrachlorethane being shown in Fig. 1, so that we can get the volume of the gas to be absorbed at the total pressure of 760 mm. by either extrapolation or interpolation as the case may be, and this is converted to mol fraction: $N'_{\mathrm{HCl}} = n_{\mathrm{HCl}} / (n_{\mathrm{HCl}} + n_{\mathrm{liquid}})$. This corresponds to the solubility of hydrogen chloride at the total pressure of 1 atmosphere expressed in mol fraction. To find the value of the solubility of hydrogen chloride, i.e. N_{HCl}, when P_{HCl} equals 1 atmosphere, Henry's law in the following form was used:

$$N_{\mathrm{HCl}} = N'_{\mathrm{HCl}} \times \frac{760}{P_{\mathrm{HCl}}} .$$

In order to find P_{HCl}, Raoult's law was assumed to hold and the values of the vapour pressures of the organic liquids were obtained from the International Critical Table and those not given directly was calculated by the equation:

$$\log_{10} P_{\mathrm{mm.}} = \frac{0.05223}{T} \times A + B . \tag{4}$$

In the case of 1,1,2,2-tetrachlorethane the data for the above expression could be obtained only for the range 26—145°, so that strictly speaking the vapour pressure calculation could not be correct, but, for the temperatures 15°, 20°, and 25°, calculation may not be so much far from the true values even if we assume it holds for 15°, 20°, and 25°C.

Tables 1–4 show the results of the absorption experiments for 20 c.c. of respective liquids at 15°, 20°, and 25°C. In Table 5, N, $\log N$, and $\frac{1}{T}\times 10^{-3}$ for 15°, 20°, and 25° for each liquid are listed, and $\log N$ plotted against $\frac{1}{T}\times 10^{-3}$ as shown in Figs. 2–4. The heat of absorption $\varDelta H$ can be calculated by

$$\frac{d\log N}{d\left(\frac{1}{T}\right)}=\frac{-\varDelta H}{2.303\times R}\,. \tag{5}$$

$\varDelta H$ for each liquid is also listed in Table 5.

Table 1. Absorption of Hydrogen Chloride into 1,1,2,2-Tetrachlorethane at 25°, 20°, and 15°C., per 20.0 c.c. of $C_2H_2Cl_4$.

Exp. No.	Pressure P mm.	Vol. of absorbed HCl reduced to $V_{25°}$ c.c.	Mol fraction N	Mol per cent.
		25°C.		
1	739.0	112.55	0.0239	2.39
2	396.0	59.38	0.0128	1.28
3	493.5	74.90	0.0161	1.61
4	614.5	94.18	0.0201	2.01
5	541.0	83.41	0.0178	1.78
6	442.0	68.04	0.0146	1.46
		20°C.		
7	731.5	122.05	0.0258	2.58
8	390.0	65.29	0.0140	1.40
9	582.0	99.27	0.0211	2.11
10	631.5	108.21	0.0229	2.29
11	680.0	114.97	0.0243	2.43
12	621.5	106.25	0.0225	2.25
		15°C.		
13	663.5	124.30	0.0261	2.61
14	384.5	72.81	0.0155	1.55
15	722.5	133.84	0.0281	2.81
16	573.5	109.81	0.0231	2.31

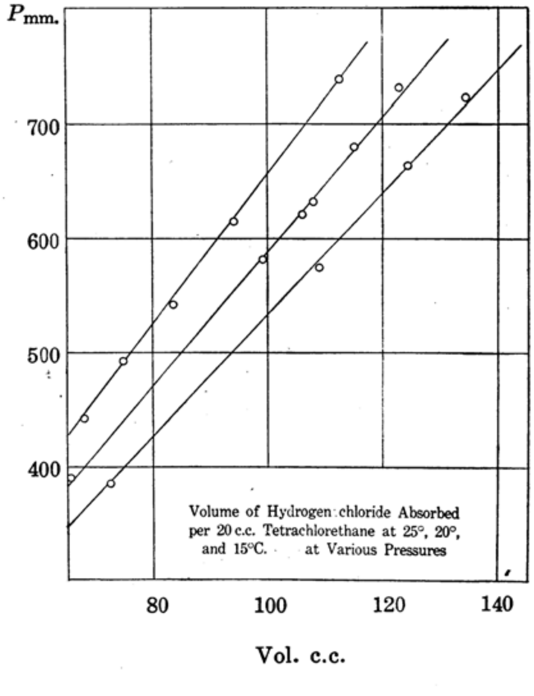


Fig. 1.

Table 2. Absorption of Hydrogen Chloride into Carbon Tetrachloride at 25°, 20°, and 15°C., per 20.0 c.c. of CCl_4.

Exp. No.	Pressure P mm.	Vol. of absorbed HCl reduced to $V_{25°}$ c.c.	Mol fraction N	Mol per cent.
25°C.				
1	631.5	40.90	0.00817	0.817
2	779.5	60.42	0.01200	1.200
3	433.5	18.28	0.00367	0.367
4	531.5	31.09	0.00622	0.622
5	680.5	47.89	0.00955	0.955
6	580.0	37.86	0.00757	0.757
20°C.				
7	770.5	70.25	0.01380	1.380
8	425.0	28.33	0.00563	0.563
9	521.0	41.83	0.00829	0.829
10	572.0	44.22	0.00876	0.876
15°C.				
11	614.0	59.89	0.01170	1.170
12	420.5	31.10	0.00613	0.613
13	515.5	47.24	0.00928	0.928
14	664.0	64.99	0.01270	1.270

Table 3. Absorption of Hydrogen Chloride into Ethylene Chloride at 25°, 20°, and 15°C., per 20.0 c.c. $C_2H_4Cl_2$.

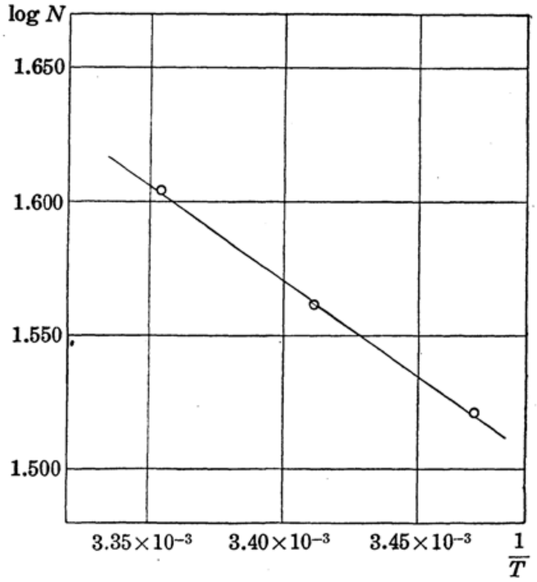
Exp. No.	Pressure P mm.	Vol. of absorbed HCl reduced to $V_{25°}$ c.c.	Mol fraction N	Mol per cent.
25°C.				
1	680.0	183.09	0.0291	2.91
2	467.5	123.49	0.0198	1.98
3	500.0	133.20	0.0213	2.13
4	584.0	158.00	0.0252	2.52
20°C.				
5	526.5	163.19	0.0258	2.58
6	526.5	163.19	0.0258	2.58
7	540.0	164.64	0.0261	2.61
8	600.0	192.45	0.0303	3.03
9	731.5	223.49	0.0350	3.50
10	520.5	159.48	0.0253	2.53
15°C.				
11	533.5	189.89	0.0298	2.98
12	342.5	118.80	0.0188	1.88
13	550.0	191.22	0.0300	3.00
14	422.0	145.20	0.0229	2.29

Table 4. Absorption of Hydrogen Chloride into Ethylene Bromide at 25°, 20°, and 15°C., per 20.0 c.c. $C_2H_4Br_2$.

Exp. No.	Pressure P mm.	Vol. of absorbed HCl reduced to $V_{25°}$ c.c.	Mol fraction N	Mol per cent.
25°C.				
1	672.0	155.08	0.0269	2.69
2	507.0	117.81	0.0206	2.06
3	368.5	87.16	0.0153	1.53
4	601.0	138.96	0.0242	2.42
5	279.0	66.40	0.0117	1.17
20°C.				
6	362.0	94.28	0.0165	1.65
7	453.5	119.11	0.0207	2.07
8	679.5	179.78	0.0309	3.09
9	496.0	129.53	0.0225	2.25
15°C.				
10	672.0	189.96	0.0325	3.25
11	354.0	103.72	0.0180	1.80
12	531.0	154.62	0.0266	2.66
13	719.0	204.37	0.0348	3.48

Table 5.

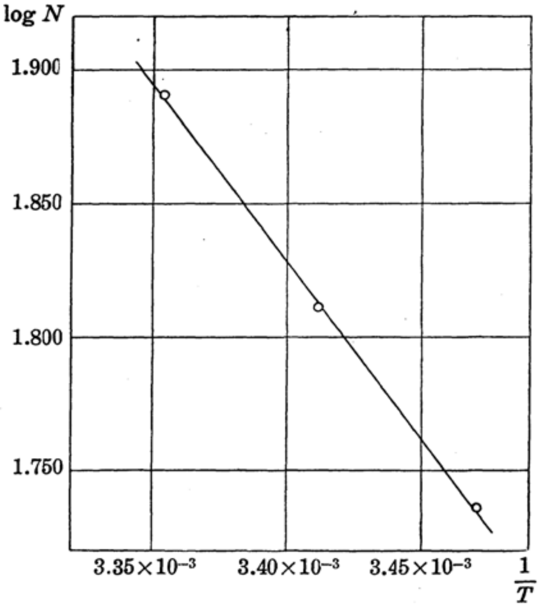
Substance	N(HCl)	log N	$1/T\times10^3$
15°C.			
$C_2H_2Cl_4$	0.03006	1.52201	3.471
CCl_4	0.01826	1.73850	3.471
$C_2H_4Cl_2$	0.04377	1.35882	3.471
$C_2H_4Br_2$	0.03754	1.42551	3.471
20°C.			
$C_2H_2Cl_4$	0.02744	1.56162	3.411
CCl_4	0.01550	1.80967	3.411
$C_2H_4Cl_2$	0.03993	1.39870	3.411
$C_2H_4Br_2$	0.03441	1.46332	3.411
25°C.			
$C_2H_2Cl_4$	0.02481	1.60537	3.354
CCl_4	0.01277	1.89381	3.354
$C_2H_4Cl_2$	0.03576	1.44660	3.354
$C_2H_4Br_2$	0.03116	1.50640	3.354
Heat of Absorption, ΔH/mol in cal.			
$C_2H_2Cl_4$	3300		
CCl_4	6100		
$C_2H_4Cl_2$	3500		
$C_2H_4Br_2$	3200		



(log $N-\frac{1}{T}$ Curve)

Variation of the Absorption of Hydrogen Chloride in Tetrachlorethane with Respect to Temperature.

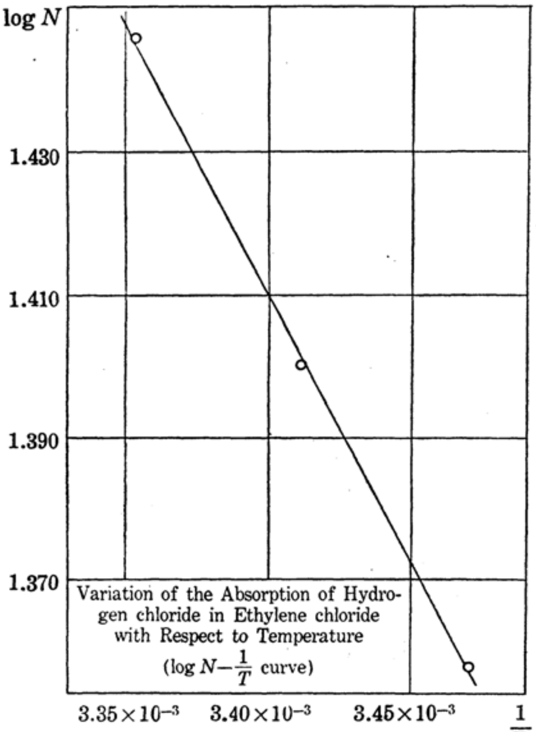
Fig. 2.



(log $N-\frac{1}{T}$ Curve)

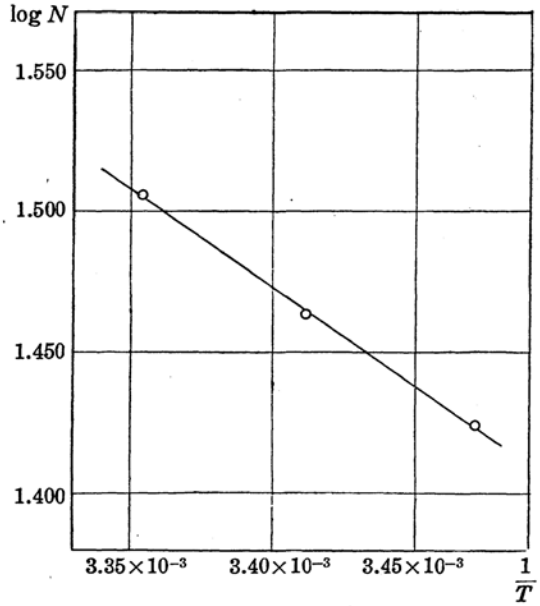
Variation of the Absorption of Hydrogen Chloride in Carbon Tetrachloride with Respect to Temperature.

Fig. 3.



Variation of the Absorption of Hydrogen chloride in Ethylene chloride with Respect to Temperature (log $N-\frac{1}{T}$ curve)

Fig. 4.



(log $N-\frac{1}{T}$ Curve)

Variation of the Absorption of Hydrogen Chloride in Ethylene Bromide with Respect to Temperature.

Fig. 5.

Discussion of Results. (a) Polarity in Connection with Solubility. Whether certain liquids into which a gas is absorbed are polar or non-polar, is very significant to the determination of the solubility of that gas. There are quite convincing evidences for the effects of polarity on solubility. Usually polar gases are more soluble in polar liquids than in non-polar liquids, and non-polar gases more soluble in non-polar liquids than in polar liquids. In other words, the degree of polarity plays a very important rôle. The dielectric constant usually can be regarded as the most direct evidence of polarity and the magnitude of it may be quite conveniently considered as a measure of degree of polarity. According to Van Vleck,(2a) "A molecule may be defined as polar if it has a permanent electrical moment, i.e. an electrical moment which is on the time average different from zero even in the absence of external fields. A molecule without such a permanent moment is termed non-polar". Then polarity of a substance can be estimated from the electric moment of the molecule in question. Besides these, other factors in the molecule such as chemical structure play important parts, that is to say, polarity is influenced by certain groups or radicals such as $-NH_2$, $-OH$, $-NO_2$, $=CO$, etc. These groups substituted in the molecule usually contribute much to the polarity of the substance in question, and the symmetry in the molecule seems to play a very significant rôle in almost every possible case such as the degree of the polarity as we find in the case of CCl_4, $CHCl_3$, CH_2Cl_2, CH_3Cl, $C_2H_4Cl_2$, $C_2H_2Cl_4$, etc., among which CCl_4 is considered to be the most symmetrical and hence the least polar.

Distinction between the polarity of the substances and that of the bond should be carefully noted especially in connection with solubility. The atomic volume is also considered to be an effective factor for determining the polarity, those elements having higher atomic volumes give higher polarity, and the element having the smallest atomic volume of all known elements—carbon—gives the least polar compounds. There are still some other factors which contribute much to the determination of polarity.(4) Besides, the polar character of a substance is also dependent on the so-called polar environment, as G. N. Lewis says, "ranging from the extremely polar to the extremely non-polar......Great as the difference is between the typical polar and non-polar substance we may show how a single molecule may, according to its environment, pass from th extreme polar to the extreme non-polar form not per saltum, but by im-

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(4) For fuller discussion on polarity, see the following: Debye, "Polar Molecules"; G. N. Lewis, "Valence and the Structure of Atoms and Molecules"*; *J. Am. Chem. Soc.*, **35** (1913), 1448; *J. Am. Chem. Soc.*, **38** (1916), 762*; J. H. Hildebrand, "Solubility"; Van Vleck, "The Theory of Electric and Magnetic Susceptibilities".

perceptible gradations, as soon as we admit that an electron may be the common property of two atomic shells."(4)* At any rate, the dielectric constant does give a rough measure of the polarity of the molecule with some exceptions. Therefore, it has been attempted to see any possible correlation between the solubility of hydrogen chloride in the mentioned organic solvents, and the polarity as measured by the dielectric constant, molecular symmetry, electric moment, Eötvös's constant, and the polarity with the effects of substituents. These are tabulated in Table 6. The results indicate that the solubility is in the order of increasing values of dielectric constants in the series of chlorine derivatives of hydrocarbon, i.e. hydrogen chloride being the most soluble in ethylene chloride with the highest dielectric constant 10.8 at 20°, next in tetrachlorethane with 8.2, and the least in carbon tetrachloride with 2.24; the same could be said with regards to the electric moment. In these cases, however, ethylene bromide does not seem to be accounted in the same categories. With respect to Eötvös's constants, and the molar volumes of the solvents we can hardly find any regularity.

Table 6.

Substance	D.C. 20°	$\mu \times 10^{18}$	Mol. vol. c.c.	Eötvös's const.		Solubility (20°) mol fraction
				Calc.	Obs.	
1,1,2,2-Tetrachlorethane	8.2	1.6	105.30	2.26	—	0.02744
Carbon tetrachloride	2.24	0	97.10	2.20	2.10	0.01550
Ethylene chloride	10.8	1.8	78.90	2.15	—	0.03993
Ethylene bromide	6.3	1.4	86.20	2.19	2.17	0.03441
Hydrogen chloride		1.03				

Table 7.

$\mu \times 10^{18}$ HCl	Solvent	Authors
1.286	Benzene	F. Fairbrother(5a)
1.273 } 1.3	CCl_4	
1.32	Cyclohexane	
1.02	Ethylene bromide	F. Fairbrother(5a)
0.97	Ethylene chloride	
1.26	Benzene	
1.034	Gaseous(5b)	Zahn
1.18	,,	Braunmühl
1.48	,,	Frivold and Hassel
2.15	,,	Falkenhangen

The electric moment of hydrogen chloride in various non-polar solvents has been reported by Fred Fairbrother.(5a) (Table 7)

Change in the effective electric moment of hydrogen chloride was found not influenced by solvents. From these we can say that, when the solvent molecules are as

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(5a) F. Fairbrother, *J. Chem. Soc.*, **1932**, 43; *ibid.*, **1933**, 1541; Hassel and Uhl, *Z. physik. Chem.*, [B], **8** (1930), 187.

(5b) Zahn, *Phys. Rev.*, **24** (1924), 400; H. J. Braunmühl, *Physik. Z.*, **28** (1927), 141; O. E. Frivold and O. Hassel, *ibid.*, **24** (1923), 82; H. Falkenhangen, *ibid.*, **23** (1922), 87.

polar as those of the solute or more polar as in the solution of ethylene bromide and ethylene chloride, the electric moment is much lessened; this can be accounted parallel with the approximate proportionality of the frequency shift with the electric moment of the molecules of the solvent in "Raman spectra of hydrogen chloride in non-ionizing solvents" which was recently reported by W. West and P. Arthor.(6) This in turn means, as they remarked, that a large part of the shift is due to dipole interaction between solvent and solute molecules. The existence of dipole interaction may indicate that hydrogen chloride has greater solubility in ethylene chloride than in any other and the solubility is roughly in the order of magnitude of the electric moment of the solvents; possibly it means more dipole interaction in ethylene chloride than in others, which in turn increases the solubility, and the fact that the electric moment of hydrogen·chloride increases in such solvents as CCl_4 and benzene as given by Fairbrother is true and the account that it is due to the stretching of the molecule in solution is concordant with the fact that hydrogen chloride is less soluble in CCl_4 than in $C_2H_4Cl_2$ and $C_2H_2Cl_4$.

(b) **Internal Pressure in Connection with the Solubility.** Although there is controversy as to whether the internal pressure as measured in various different ways gives some correlation with solubility or not, it is very interesting to see the actual cases. Those data selected and given in "Solubility" by Hildebrand seem to give a very good criterion in the discussion of solubility, but W. Kunerth(7) has given some contradictory evidences to usefulness of the internal pressure from the study of the solubility of CO and N_2O in some twelve organic liquids. Before we go into the detailed discussion of our results in the light of the internal pressure it would be profitable to state what we mean by the internal pressure of the liquid. Accepting a definition given by Hildebrand internal pressure is the maximum negative pressure that a liquid could support if no nuclei of vapour were allowed to form. The internal pressure can be best estimated if the internal forces which operate in liquid could be known well. We therefore, must have definite knowledge, of their equation of state for liquid in question as already stated, and of $-T\frac{\alpha}{\beta}$ as a measure of internal pressure. Relative internal pressure could be estimated in various ways, for instances, from van der Waals's equation, coefficient of expansion, heat of vaporization, boiling points $\frac{5200+30t_b}{V}$, surface tension, and total surface energy.

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(6) W. West and P. Arthor, *J. Chem. Phys.*, **2** (1934), 215.

(7) W. Kunerth, *Phys. Rev.*, **19** (1922), 512.

The values of the internal pressure are not quite concordant as the methods of calculation differ and it is very difficult to find what method we should most rely upon in correlation with solubility. Some of these values of the relative internal pressure from various methods are tabulated with our solubility data in Table 8. As far as the comparison in the table is concerned, we hesitate to draw any definite conclusion upon this point.

Table 8.

Subst.	$T\frac{\alpha}{\beta}$	Mathews(9)	Sutherland(9)	$E/V^{\frac{1}{3}}$(9)	$\frac{(n-1)L}{V}$	$(5200+30t_b)/V$	Van Laar's a	$\gamma/V^{\frac{1}{3}}$	$N(20°)$
CCl_4	3362(8) 3690	2660	490	14.3	308	77.06	496	5.78	0.01550
$C_2H_4Br_2$	4455(8) 4760	3900	710	17.2	422	105.23	549	8.7	0.03441
$C_2H_4Cl_2$	4153(8)	—	—	17.0	406	97.45	475	7.5	0.03993
$C_2H_2Cl_4$	—	—	—	15.58	368	90.72	555	7.71	0.02744

Table 9.

Bond	Bond energy in v.e.(2b)(2c)
C – Cl	3.22(10)
C – Br	2.89(10)
C – H	4.34
C – C	3.6
Substance	**Total bond energy in v.e.(11)**
CCl_4	12.88
$C_2H_4Br_2$	26.74
$C_2H_4Cl_2$	27.40
$C_2H_2Cl_4$	25.16

With exception of $C_2H_4Br_2$, the solubilities of hydrogen chloride in these liquids lie in the order of their relative internal pressures.

After taking the polarity and the internal pressure into consideration of influencing factors of the solubility of hydrogen chloride gas in each case, we find that $C_2H_4Br_2$ comes out to be exceptional in these discussions, hence we must look for some additional causes. Not only the dielectric constant for determining the polarity of molecule, but also other properties of it should

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(8) J. H. Hildebrand, *Phys. Rev.*, **34** (1929), 649,

(9) "Solubility" by J. H. Hildebrand.

(10) Average of values of the various authors are used:
A. Sherman and C. E. Sun, *J. Am. Chem. Soc.*, **56** (1934), 1099.

(11) "The observed energy of the molecule is equal to that calculated for an assumed distribution of bonds or differs from it in the direction corresponding to greater stability in accord with the quantum mechanical requirement that the actual energy for the normal state of any system is the lower limit for values of the energy integral calculated for any wave function". L. Pauling and J. Sherman, *J. Chem. Phys.*, **1** (1933), 607.

be taken into account. For instance, the kind of halogen substituted and chemical stability as estimated from the relative strength of bonds involved in the compound:

Total bond energy

$$C_2H_4Cl_2 > C_2H_4Br_2 > C_2H_2Cl_4 > CCl_4$$

Solubility

$$C_2H_4Cl_2 > C_2H_4Br_2 > C_2H_2Cl_4 > CCl_4$$

The solubility of hydrogen chloride lies in the order of the strength of bonds as estimated by total bond energy similarly calculated as L. Pauling has done by assuming the additivity of energy. The strength of bonds as indicated by the total bond energy can be interpreted that those with larger bond energy are more capable of standing against external disturbances such as stretching or compression of bonds in these compounds effected as the solute molecules dissolve into them; in other words, those solvents with higher bond energy are possibly more capable of holding more solute molecules.

Summary.

(1) Absorption of hydrogen chloride into CCl_4, $C_2H_4Cl_2$, $C_2H_2Cl_4$ (1,1,2,2), and $C_2H_4Br_2$ at 15°, 20°, and 25°C. has been studied.

(2) The heats of absorption of hydrogen chloride into these solvents were calculated.

(3) The relations between the solubility and polarity of organic liquids involved, and also the internal pressure have been discussed.

(4) The solubilities of hydrogen chloride in these liquids have been found in the order of increasing bond energies of the liquids calculated similarly as Pauling has done, and a possible explanation of it has been suggested.

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